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The Empire Plant

A waving and seemingly endless sea of grass unfolded before westward-bound settlers as they forded the Wabash River. The vast grassland which awed them forms a triangular peninsula whose other points stretch away into Texas and Saskatchewan. In those days it was the ancient domain of the Indian where tribal life revolved around the productivity of grass and the countless herds of buffalo it sustained.

Farming and ranching long ago altered our original grasslands so that only a few primeval remnants are now preserved. Although the character of the great North American grassland has been drastically changed, grass itself endures in our lives.

For example, grass is a proven ally in many battles for conservation. Grass both protects and restores. Its sheltering blades and network of roots mock at erosion—holding the pelting rainfall and leading it safely underground. When landscapes are abused, whether by erosion, stripmining, overcropping or construction, it is grass that we turn to for healing and renewal.

Grass helps make beef. Our western ranges are a major resource, even in this day of large mechanized feedlots. Most feedlots buy their feeders from ranchers who run cow-calf operations, enterprises based on grass. Indeed, grass and hay account for about three-quarters of the nutrients that beef cattle consume over their lifetimes.

Grass serves us in countless other ways. To cite only a few: it mantles playgrounds, parks, and golf courses. Its green lushness on lawns provides balm for tired eyes and frayed nerves. It acts as a living filter for purifying sewage. It helps recharge the biosphere with life-sustaining oxygen.

Although grass is the most numerous member of the plant kingdom, some species have to be reshaped to meet changing needs. ARS scientists are involved in this effort. Over the years they have introduced and improved grasses for many uses that benefit farmer, rancher, and townsman. A major thrust of today's research is the transfer of desirable genetic characteristics from one species or genera to another by exploiting the varied and often complex reproductive mechanism of grasses. Another important line of work is identifying the substances which render some species unpalatable to livestock.

The gift of grass is ours to use and cherish. Those who learn to live with it and manage it wisely will have learned much about the harmony that can exist between man and land.

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COVER: In a sugarcane test plot, technician Jesse Floyd checks water table depth with a piezometer, a small metal tube sunk in the ground (page 6). Water rises in the tube to the level controlled by the sump. If the water table is not at the correct depth, adjustments are made at the sump (571X465–18).

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Clifford M. Hardin, Secretary
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Chemist Martha Horrocks feeds a carbohydrate diet to a laboratory rat in studies to compare the effects of two types of carbohydrates as the main calorie source (671K700–7).

The CARBOHYDRATE QUESTION

One step towards diets that may reduce heart disease

HOW DO CARBOHYDRATES in the diet affect fat metabolism and hormone status? The answer to this question could lead to dietary recommendations that would help postpone or avoid atherosclerosis and heart disease.

Human nutrition scientists at Beltsville, Md., are trying to find out how to avoid the development of a metabolic pattern in which the liver synthesizes lipids (fats) from carbohydrates at an excessive rate. Headed by physiologist David Trout, the scientists seek not only an explanation of the way carbohydrates

are involved; they hope to be able to identify people who are likely to develop this metabolic pattern.

The research group is presently concentrating on two areas: (1) Liver metabolism, which produces most of the lipid and lipoprotein (proteins united with fatty substances) of human blood plasma; and (2) insulin status, known to be importantly involved in human atherosclerosis.

The tendency for the liver to synthesize too much fat from carbohydrates is a common condition believed to promote atherosclerosis in man. When high levels of fat and cholesterol are produced in the blood, the result is known as carbohydrate-induced hyperlipemia. A main factor here appears to be an overabundance of specific liver enzymes that speed the various chemical reactions taking place in fat synthesis. Dr. Trout and his assistants are particularly interested in understanding how diet affects the level of these "lipogenic" enzymes so important in the production of fat.

Recent studies indicate that the kind of dietary carbohydrate is important. When male rats from two different strains were fed nutritionally adequate diets differing only in the kind of carbohydrate—sucrose, glucose, or cornstarch—they showed differences in body weight, in liver fat, and in the activity of several lipogenic enzymes in the liver. In both strains, there was a greater increase in liver fat and in the lipogenic enzyme, glucose-6-phosphate dehydrogenase, with rats fed sucrose.

Nutritionist Carolyn Berdanier weighs a rat bred to be fat. Researchers are studying the nutritional responses of these rats as possible models of carbohydrate sensitivity in man (671K699–6).

In a study of short-term effects of carbohydrate in a nutritionally adequate, 25-percent dried, whole egg diet, the kind of carbohydrate influenced the levels of liver fat and of two key enzymes involved in fat synthesis. The three test diets were identical except for the carbohydrate—sucrose, cornstarch, or fructose. Again, higher enzyme levels were associated with sucrose than with starch.

The hormone insulin also plays a role in the regulation of these enzymes. Dietary carbohydrate stimulates the pancreas to release insulin, which then serves as a kind of chemical messenger. Results of a recent study suggest that control of the synthesis of one important lipogenic enzyme; namely, malic enzyme, is regulated chiefly by insulin and dietary carbohydrate. On the other hand, control of the enzyme glucose-6-phosphate dehydrogenase is subject to more complex regulation involving insulin, dietary protein, and perhaps other factors.

Rat experiments also suggest that insulin status early in life may have important, long-lasting effects on enzymes and lipid metabolism. Studies were made of two rat strains showing high levels of blood insulin for some weeks after weaning. The blood insulin later fell to levels similar to those of other rat strains. However, lipogenic enzymes in the liver and, under certain conditions, liver fats were found to be elevated long after the insulin level returned to "normal."

In a further study, high-insulin levels were brought about in a strain of rats normally having moderately low levels of blood insulin at all ages. This was accomplished either by administering insulin or by feeding tolbutamide, a drug which increases the release of insulin by the pancreas. When these rats matured, they showed changes in metabolic pattern similar in many respects to those observed in the first two strains of animals, which displayed high levels of blood insulin when they were young. □

Promising new herbicide for NUTSEDGE

MBR 8251 was applied as a preemergence treatment on this weed-free half of a flat planted with soybeans, peanuts, and nutsedge (571X554–8).

AN EXPERIMENTAL HERBICIDE designated MBR 8251 has shown dramatic results in controlling nutsedge, a plant that has been labeled the world's Number One weed.

In the United States, purple nutsedge infests fields in the South Atlantic and Gulf Coast States and from the middle of southwestern California east to southwest Arizona. Yellow nutsedge is found in all States except North Dakota and Alaska.

Both weeds affect almost all agricultural crops. They are difficult to cope with because their seed, rhizomes, and tubers remain viable in soil for years. Normal tillage brings them near the surface where they spring to life and crowd out crops, usurping valuable water and nutrients.

But MBR 8251 may solve this widespread problem.

In experiments at Beltsville, Md., the chemical was highly selective in controlling nutsedge in corn, flax, snap beans, soybeans, peanuts, cotton, cabbage, rape, and cucumbers. ARS plant physiologist Walter A. Gentner applied the compound MBR 8251 as a preemergence spray, as a postemergence foliar spray, and as a preplant soil-incorporated treatment, in which it was sprayed on the soil and mixed to a depth of 4 inches before the crops were planted.

Though application rates as high as 8 pounds per acre were used in the experiments, nutsedge was satisfactorily controlled with rates as low as 2 lb./a. In all tests, 2.5 lb./a. of the chemical controlled 70 percent of the nutsedge population.

Dr. Gentner is continuing this series of tests and is evaluating related compounds to determine whether they can control nutsedge better.

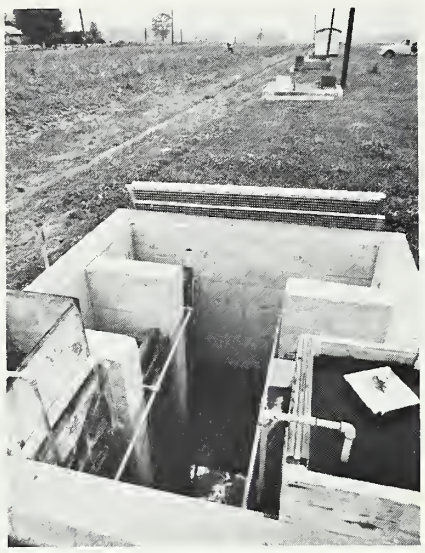
He says that MBR 8251 also has potential as an effective herbicide against many other grassy and broadleaf weeds—especially in view of the exceptionally low rates needed.

Although MBR 8251 appears to open a new avenue to controlling nutsedge with the use of less pesticide, additional studies are needed to determine whether it is biodegradable, toxic to warm-blooded animals, or could in any way adversely affect the environment.

The new herbicide is not registered for any of the uses evaluated in these experiments. Before a pesticide can be released to the public, it must undergo stringent tests by its manufacturer, who then submits test data and the product to the Federal Government for evaluation and registration. □

To determine most satisfactory rate of application, Dr. Gentner placed various crop and weed plants in flasks containing different concentrations of the herbicide (171X08–2).

Right: *To measure amount of soil water, a radioactive source, called a neutron probe, is lowered down tube to desired depth. Reading is recorded on electronic scaler and compared to a soil water calibration curve (571X465–29).*



Right: *One of the sumps used to control water levels in test plots (571X465–14).*

Louisiana sugarcane

WATER MANAGEMENT for HIGH YIELDS

SOIL WATER MANAGEMENT in Louisiana sugarcane fields offers farmers in that State a potential gross income increase of more than $30 million annually.

Through water management—removing surplus water during periods of high rainfall and supplying water during droughts—ARS researchers achieved production as high as 50 tons of sugarcane per acre in 1 year. The State average in 1969 on slightly less than 300,000 acres was 24.5 tons per acre. Except for the water treatments, conventional methods of cane culture were used. The Louisiana Agricultural Experiment Station, Baton Rouge, cooperated in the research.

Water management extends one planting of cane into three, and possibly four and five harvests, at better than 40 tons per acre each year. Normally, cane yields decline sharply after the first ratoon (sprouting from roots) crop. Usual practice is to plow and replant after the second harvest. Increasing the longevity of cane at high-yield levels increases profits with little increase in costs. The additional harvests are dependent on good weed control.

The water table treatments apparently did not affect sucrose content or total solids of the cane juice. There were no statistical differences in cane yields, sucrose, or Brix value (sugar in solution) among treatments.

Most Louisiana farmers depend on an erratic rainfall to supply cane with water. Precipitation ranges from 40 to 85 inches per year, but some months may get from none to 20 inches. Too much as well as too little water inhibits cane growth and yields.

ARS agricultural engineer Cade E. Carter of Baton Rouge, La., soil scientist Charles B. Elkins of Athens, Ga., and technician Jesse M. Floyd of Baton Rouge, used four water table treatments—24, 32, 40, and 48 inches in depth—on concrete-bordered plots. The concrete border was needed only for the study. Each plot was equipped with tile drains connected by pipe to a sump where there was a water supply, valves, and drain for maintaining the water level at any desired elevation from near the soil surface to 5½ feet deep. Yields were compared with those on a nearby site under similar treatment, except for water management, as well as with average yields in the cane growing area.

Sugarcane plants adapted readily to the various soil water regimes, since yields from each treatment were excellent with plant cane, first-year stubble, and second-year stubble. Yields from all treatments were above 40 net tons per acre each of the 3 years of the experiment. Highest average yield for the 3 years—46 tons per acre—came from the 40-inch treatment plot. It had a high yield of 50.3 tons per acre the first year of the study.

One-year data from another part of the study—surface and subsurface irrigation—indicate that more than 40 tons per acre of sugarcane can be expected from that type of water treatment when coupled with subsurface drainage. Irrigation boosted second-year stubble yields about 63 percent over yields from cane plots that had no water management treatment.

A rough estimate indicates that it would take about $100 per acre to prepare a field for water table management. □

Remote sensors

SPOTTING SICK CITRUS

CITRUS TREES damaged by certain diseases, insects, and soil nutrient toxicity can be identified by analyzing aerial photographs.

Yet, a camera mounted in a high-flying plane doesn't "know" a healthy citrus tree from a sick one. So how does photographic remote sensing operate?

Plant disorders produce physical changes. Some are external—such as yellowing of leaves. Others involve changes in internal structure or water content of leaves. These changes may produce significant differences in the amount of light reflected from leaves of healthy and sick citrus.

Moreover, the proportion of light reflected, transmitted, and absorbed by the same leaves may be markedly different in the visible (500 to 750 nanometer), near-infrared (750 to 1,350 nm.), and medium-infrared (1,350 to 2,500 nm.) wavelength ranges.

Reflectance differences caused by variations in leaf pigments (chlorophylls and carotenoids) are greatest at 500 to 750 nm.; those associated with differences in leaf structure, at 750 to 1,350 nm.: and those related to water content, at 1,350 to 2,500 nm.

Identifying a physical condition, both associated with the plant disorder and responsible for significant differences in reflectance, is thus a starting point in developing photographic remote sensing techniques. Then, scientists determine the wavelength range where reflectance differences are greatest, the most advantageous photographic film and filter combination, and the appropriate techniques for photographic interpretation and data analysis.

The following examples illustrate how the ARS remote sensing research team at Weslaco, Tex., is combining information from plant, soil, and physical sciences to detect citrus disorders.

High chloride or boron levels in soils produce reduced green pigmentation of citrus leaves. Boron-affected leaves have yellowish areas; excessive levels of both boron and chloride produce browning of leaf tips. And at the 550 nm. peak in the near-infrared range, such leaves show approximately 12 percent lower reflectance than healthy ones.

One symptom of citrus foot rot, a fungus disease, is chlorosis—yellowing or blanching of leaves. Affected trees are readily identified when photographed with aerial color infrared film and a light orange filter. Trees with advanced cases of foot rot photograph white, and healthy ones photograph red.

Damage by brown soft scale, the most important insect pest of citrus in the Lower Rio Grande Valley, can be identified indirectly by remote sensing techniques (AGR. RES., September 1969, p. 10). The scale insect excretes "honeydew" soon after establishment on citrus leaves, and the black, sooty mold developing rapidly on the honeydew reduces light reflectance. At 770 nm., reflectance values for leaves heavily coated, lightly coated, and free of sooty mold were 58, 14, and 9 percent, respectively.

Research at Weslaco also includes study of factors affecting reflectivity of healthy plant leaves. Leaf age, dryness, and spray residue coatings are examples. Their effects on reflectance may mask those caused by disorders or be confused with them unless understood.

These studies show, for example, that differences in internal structure of mature and young citrus leaves affect reflectance. Young leaves are compact, with few air spaces among the mesophyll cells, but mature leaves have many air spaces and more reflecting surface. In the near-infrared range, mature leaves showed about 15 percent higher reflectance than young ones. □

Spectroradiometer in lift records reflected radiation from the sun. Data are compared to obtain accurate information on amount of light absorbed, transmitted, and reflected by crops (ST–4703–16).

Right and below: *To mark the precise location in the soil of the inhibitor-fertilizer mixture, a nylon string is drawn from the base of the applicator shank and buried as mixture is applied (571X460–18; 571X460–7).*

Right: *To obtain soil samples, researchers dig a hole along the application line to locate the string marker. They then take concentric samples from around the string (571X461–31).*

Keeping ni

SMALL AMOUNTS of potassium azide added to anhydrous ammonia fertilizer help insure against possible nitrate pollution of ground water in certain crop production situations.

The potential role of nitrogen fertilization in pollution of the Nation's water supply has created renewed interest in ways of suppressing nitrification. In nitrification, soil micro-organisms convert fertilizer nitrogen from the immobile ammonium form to nitrate, which readily moves with soil water.

Maintaining fertilizer nitrogen in the ammonium form with nitrification inhibitors would not only restrict loss to soil water through leaching and runoff but also keep applied nitrogen available to plants for a longer time.

Left: Technician Ronnie Fremin cans and labels soil samples, then places them in ice chests to retard biological activity (571X461–1). Below: In tests to find the best application rates, Dr. Parr and chemist Sammie Smith check retention of fertilizer-inhibitor mixture in soil samples (571X469–3).

Below: From fall until spring, Verlan Cochran and Dr. Papendick at Pullman, Wash., periodically took soil samples from the fertilizer-inhibitor application zone in a field seeded to winter wheat (BN–37982).

ogen in the field

The inhibitors could also decrease loss from the plant root zone of fertilizer nitrogen occurring through the denitrification of nitrite and nitrate.

In addition, inhibitors would permit fall application of ammoniacal fertilizers in regions where such practice is not presently feasible because of rapid nitrification and leaching. An inhibitor would in effect delay the application until low temperatures assume the dominant role in retarding nitrification. The nitrogen would thus be maintained in an immobile form in the rooting zone of young plants through the winter leaching period, insuring a maximum amount of nitrogen for spring growth.

ARS soil physicist Robert I. Papendick, at Pullman, Wash., and ARS microbiologist James F. Parr, Baton Rouge, La., jointly developed procedures for formulating and applying solutions of anhydrous ammonia and nitrification inhibitors to soil. They tested them at both locations in cooperation with the Washington and Louisiana Agricultural Experiment Stations.

The researchers applied 100 pounds of anhydrous ammonia in formulations of 0, 2, and 6 percent potassium azide to fallow soil in August. Both levels of potassium azide were effective in reducing the nitrification rate during the early postinjection period. The rate of 200 lb./a. anhydrous ammonia with 2-percent potassium azide was more effective at later dates.

Two months after application, 64 percent of the nitrogen applied in the 6-percent formulation remained in the retention zone; 52 percent with the 2-percent formulation, and only 33 percent where ammonia was applied without potassium azide. Nitrification inhibition through use of potassium azide was still evident 6 months after application, particularly at the high (200 lb./a.) nitrogen rate.

Current studies at Pullman and Baton Rouge have led the scientists to investigate other chemical inhibitors that are inexpensive, easily formulated and applied, and that do not form residues. The chemicals must also be nontoxic to plants and remain stable and potentially active in liquid anhydrous ammonia for long periods. □

Dr. Arisumi pollinates hybrid daylily in a greenhouse at Beltsville (671K695–9).

setting seed in daylilies

KNOWING which temperatures are most favorable for seed set in daylilies should minimize the difficulty of hybridizing them.

Daylilies—ideal plants for combining soil-erosion control with beauty—are often used in public plantings. They also provide color during the hot summer months when other flowers have given up. But sterility and difficulty in setting seed have at times delayed progress toward such advances as ever-blooming varieties, greater color variety, purer colors, and more color-fast blooms.

Breeders, who know that daylily flowers pollinated during hot weather fail to set seed, have needed the meaningful comparisons from research by ARS geneticist Toru Arisumi, Beltsville, Md., on the number of seeds produced at different temperatures.

In the study, Dr. Arisumi used two varieties, Vulcan and Caballero, both of average fertility. They were grown outdoors until early winter, when they were brought into the greenhouse for flowering. Greenhouse temperatures were maintained at 72° to 75° F. during the day and night for the 70 to 80 days until the plants bloomed.

One flower on each plant was pollinated between 8 and 9 a.m.—Vulcan with pollen from the variety, Queen of Gonzales, and Caballero with pollen from Vulcan. Temperature was controlled, but light and humidity were not.

Plants pollinated at 75° had a significant increase in the number of seeds when compared to those pollinated at 85° and 95°. And 85° was not as harmful to seed set as 95°.

Both varieties produced little or no seed when the flowers were exposed to 85° or 95° immediately after pollination for a duration of 1 or 2 days.

Generally, keeping the flowers at 75° for a day or two after pollination and then raising the temperature to 85° or 95° was not as harmful to seed set as the higher temperatures immediately following pollination. However, 2 days at 95°, even when preceded by 1 or 2 days at 75°, did some harm.

Now involved in more detailed temperature studies, Dr. Arisumi explains that all research that will help breeders overcome sterility or difficulty in seed setting will result in more and better varieties of daylilies—daylilies that will be showy, vigorous, and tailored to meet specific situations. □

EXHAUST FUMES

reducing this hazard in potato warehouses

DANGEROUS carbon monoxide gas in potato warehouses from internal combustion engines in power loaders can be reduced by employing properly tuned liquid petroleum gas engines and catalytic mufflers.

Carbon monoxide (CO) is a colorless, virtually odorless, tasteless, and nonirritating gas resulting from the incomplete combustion of fuels. Like oxygen (O_2), CO enters the bloodstream through the lungs, but because of its greater affinity for hemoglobin—200 times that of O_2—it replaces O_2 in the blood with potentially harmful results.

Reports received by ARS agricultural engineer Paul H. Orr at the Red River Valley Potato Research Center, East Grand Forks, Minn., indicate that workers in closed potato storages often suffer from headaches and dizziness when potato loaders are operating.

Mr. Orr and agricultural engineers Henry L. Kucera and J. Raymond Mewes of the North Dakota Agricultural Experiment Station, Fargo, evaluated the composition and harmful effects of exhaust gases during closed building operations.

They compared gasoline and liquid petroleum (LP) gas engines using both normal and 10-percent rich air-to-fuel ratios. Engines operated on a cycle of load and no-load conditions in order to simulate actual usage in a warehouse.

Tests also compared regular stock mufflers with catalytic mufflers. A catalytic muffler is an exhaust-purifying device that reduces exhaust products. It utilizes a ceramic honeycomb with holes containing wires, usually of platinum, to oxidize exhaust gases.

Tests showed that LP gas engines produced 50 percent less CO than gasoline engines, and normal air-to-fuel ratios produced 42 percent less CO than engines operating at 10-percent rich setting.

When compared with stock mufflers, catalytic mufflers reduced CO by 40 percent. However, exhaust gas irritants, which usually warn workers of CO presence, were also reduced.

Based on these tests, concentrations of CO in a closed building can be estimated if the warehouse free-air volume, type of engine, and building infiltration rate (rate of leakage or change of air in any structure) are known. The estimate is obtained with the following equation:

$$Cw = \frac{10{,}000\ CxT}{V(1+PT)}$$

"*Cw*" equals CO concentration after "*T*" hours and "*Cx*" equals CO concentration after 1 hour for known engine types, both in percent by volume; "*T*" equals engine running time in hours; "*V*" equals warehouse airspace volume in cubic feet; and "*P*" equals the infiltration rate per hour (set "*P*" at 10 percent for potato warehouses).

Dangerous *Cw* values range from 0.02 percent, which causes mild headaches after 2 to 3 hours' exposure, to 1.28 percent, which causes unconsciousness and possibly death in 1 to 3 minutes.

Although use of LP gas engines, catalytic mufflers, and normal air-to-fuel ratios will reduce CO concentrations, caution must still be exercised because CO was never completely eliminated in any of the tests. □

Water witching ____ by meter

IT WAS BOUND to happen. Water witching has come of age, in a sophisticated sort of way.

ARS scientists in Arizona are detecting water-storing basins—aquifers—with the use of a gravity meter so sensitive that it can detect the variation in the earth's gravitational attraction at different floors of a multistory building.

That doesn't mean that water can be detected by the device, only that it can detect those places where water is likely to be found. Basically, the gravity meter detects and measures lateral variations in the earth's gravitational pull that are associated with near-surface changes in density.

An example would be the Walnut Gulch watershed near Tucson. There, ARS geologists Delmer E. Wallace and Daniel P. Spangler took gravitational readings and plotted the contours reflecting the alluvium-bedrock interface—where the sediment and bedrock meet—of the basin. From those data, they estimated the total alluvium volume within the basin—40 cubic miles.

Using known porosity values for the alluvial material and water-level depths from observation wells, the scientists calculated that 2.64 cubic miles (8,900,000 acre-feet, 2,900 billion gallons) of ground water are stored in the basin. These calculations indicated that the alluvial aquifer can store much more groundwater than now exists in the basin if recharge is manipulated and other water management practices are used.

Groundwater is vital to irrigated agriculture, and many cities in the Southwestern United States rely on groundwater for their municipal needs. Tucson, a city of about 350,000 people, depends entirely on groundwater for its water supply and uses nearly 18 billion gallons annually. The alluvium filling the large deep valleys of the Southwest stores huge quantities of groundwater, and the exploration for groundwater in these basins is extremely important to keep pace with the area's explosive growth.

The gravity meter, which has been used extensively in past years in petroleum exploration, may be one means of cutting the costs of determining the extent and volume of these alluvial aquifers. Large areas and extreme depths must otherwise be studied by exploratory drilling, which is often prohibitively expensive.

This type of research encompassing large areas paves the way for more intensive studies as knowledge of various regions increases. The exploration of large alluvium-filled basins by the gravity method helps scientists predict the amount of groundwater available for future use in the Southwest—and possibly elsewhere in the world. □

Are carriers the culprits in bee deaths?

Conflicting reports on the toxicity of herbicides to honey bees may result partly from the difference in carriers.

Some carriers, diesel oil in particular, used to apply herbicides can be toxic to honey bees. Thus, the same herbicide can have different toxicity levels, depending on the carrier.

ARS entomologist Joseph O. Moffett, technician Robert H. Macdonald, and plant physiologist Howard L. Morton, all in Tucson, Ariz., tested nine herbicides in phytobland oil, diesel oil, water, and oil-and-water carriers. They followed ratios recommended on the labels.

Three herbicides — monosodium methanearsonate, paraquat, and cacodylic acid—were shown to be toxic no matter what carrier was used. The other six—2,4-D; 2,4,5-T; silvex; picloram; endothall, and a 1:1 mixture of the triethylamine salts of 2,4,5-T and picloram—were nontoxic so long as water was used for a carrier. All of the above herbicides except picloram and 2,4,5-T are registered for use on various crops.

Of the carriers tested, diesel oil and phytobland oil were the most toxic to bees. A combination of diesel oil and water was less toxic than diesel oil alone, but still more toxic than water. □

Analyzing maple flavor

Americans prize the distinctive flavor of maple sirup, maple sugar candy, and a wealth of other maple products. But until recently, chemists could not separate and identify the flavor-imparting compounds.

Now with the help of gas chromatography and mass spectrometry, 25 compounds related to the flavor in maple sirup have been identified by chemists working under J. Clyde Underwood at the ARS Eastern marketing and nutrition research laboratory, Philadelphia, Pa.

This knowledge could provide maple producers with a uniform set of standards for controlling flavor quality to replace the subjective taste tests. Furthermore, objective standards paired with gas chromatography would help in detecting sirup adulteration.

Though some naturally occurring flavors are due mainly to one simple compound which imparts a distinctive taste to the product, this is not the case with maple. Indeed, compounds other than the 25 already found may contribute to maple flavor. The chemists cannot yet artificially duplicate the full natural maple flavor by combining the identified compounds.

To isolate the compounds for identification, the maple sirup was shaken with chloroform. A portion of the extract was then injected into a gas chromatograph. The solvent and the extracted compounds passed through the chromatograph at different rates, thus separating. As they came out of the chromatograph, amounts were recorded on paper as a series of peaks—greater amounts, taller peaks—and each compound was collected and analyzed.

The geographical source of the maple sap did not qualitatively affect the flavor compounds in maple sirup. Thus a set of standards developed for judging sirup would be applicable all over the country. □

Dr. Underwood examines a profile of maple sap flavor components that was recorded by the gas-liquid chromatograph behind him (1170A1054–11).

Good-tasting and long-lasting
POWDERED MILK

A NEW POWDERED MILK PRODUCT tastes like fresh milk when first made and retains an acceptable flavor for months, even without refrigeration.

Dried milk can develop off-flavors such as an "oxidized" flavor resulting from exposure of the fat to air, a "cooked" flavor from high pasteurization temperatures before drying, and a "coconut" or stale flavor in storage.

To make the new product, chemists Arjen Tamsma, Floyd E. Kurtz, and Michael J. Pallansch at the ARS Eastern marketing and nutrition laboratory in Washington, D.C., deodorized the milk fat separately, then recombined it with skim milk that had been pasteurized at moderate temperatures to avoid the "cooked" flavor. They protected the fat from exposure to air during the process.

Finally, they concentrated the recombined milk and dried it by their foam spray process in which a gas such as air or nitrogen is injected into the concentrate so it dries as a foam. In canning the powder, most of the oxygen was replaced with nitrogen and hydrogen and a catalyst was added to convert any remaining oxygen to water vapor.

Without the deodorization step, protecting the fat of whole-milk powder from oxygen did not prevent the powder from developing an off-flavor in storage. Earlier research at the Pennsylvania State University (AGR. RES., April 1968, p. 10) had shown the off-flavor to arise from lactones, organic compounds whose precursors are naturally present in milk fat. The university scientists proposed that the fat be separately steam deodorized—treated in a vacuum with superheated steam. This would speed the conversion of precursors to lactones from months to hours. Then the lactones could be volatilized in the vacuum and carried away by steam as quickly as they appeared.

Although exhaustive steam-deodorization of the fat removed its characteristic flavor, the ARS scientists found that partial deodorization converts and volatilizes enough of the lactones to prevent the off-flavor yet retains enough of them to preserve a good initial flavor.

The next step was to utilize continuous methods for preparing partially deodorized butterfat and combining it with skim milk without exposure to air.

After refrigeration for 6 months, the new product can be distinguished from fresh milk by only a few experts. Even without refrigeration, the flavor remains good—actually better than that of control powders made from fresh milk and stored under refrigeration. □

Using experimental pilot plant equipment, Drs. Kurtz and Pallansch deodorize butterfat with steam. Steam generated in the flask (foreground) flows through vacuum chamber (right rear) to heat butterfat to 150° C. (671X689–11).

Stocking rates for blue grama

Ranchers can take full advantage of growth spurts on blue grama grass range by adjusting stocking rates to a newly developed guideline.

Blue grama ranges usually grow in brief spurts when moisture becomes available. The quantity of forage produced during these favorable periods depends largely on how much leaf tissue is working to produce food for plant growth.

The amount of ungrazed leaf tissue on the range is the key factor in maximizing forage growth and consumption, reports ARS range scientist Robert E. Bement, Fort Collins, Colo. The amount of ungrazed vegetation, in turn, is a good indicator of the amount of leaf tissue.

Dr. Bement compared varied stocking rates to determine the most favorable balance between forage consumption and forage production in experiments conducted in cooperation with the Colorado Agricultural Experiment Station, Fort Collins.

Grazing management that left 300 pounds of ungrazed herbage per acre at the end of the season—and did not reduce ungrazed vegetation to less than 300 pounds at any time during the season—gave optimum herbage production plus optimum beef production. At this grazing rate, cattle returns, in dollars per acre, were highest—more than 50 percent higher, for example, than when only 150 lb./a. of ungrazed herbage was left.

Improved steam scalding for poultry

Steam scalding of poultry could help reduce bacterial contamination, pollution, and water requirements, but processors are making only limited use of steaming methods devised so far.

One of the problems has been uneven scalding—too much on some parts and not enough on others.

To develop a better steaming method, ARS scientists at the Western regional research laboratory, Berkeley, Calif., are experimenting with steaming under subatmospheric pressure.

In limited tests, chicken fryers were satisfactorily scalded before mechanical feather removal by exposure for 2 to 3 minutes to 130° F. steam at a vacuum of 25.5 inches mercury. This is about 15 percent of standard atmospheric pressure, which is the pressure exerted by air at sea level.

Chemists Alvin A. Klose and Morris F. Pool, chemical engineer Vern F. Kaufman, and microbiologist Henry G. Bayne conducted the development research.

In studies so far, subatmospheric steam scalding appears to have two main advantages over atmospheric steam scalding: (1) Better control of the scalding temperature over the entire bird surface, and (2) better heat transfer through the feathers to the follicle structure that controls feather release.

Steam scalding itself has several benefits. In the current water-immersion process, the feathers and continuous overflow from the tank go into the plant's waste stream. The feathers add to the pollution before they are recovered for conversion to meal. Steam-scalded birds are essentially dry, lowering water requirements and eliminating tank overflow. Feathers could be kept out of the waste stream entirely to simplify transporting and converting them to meal.

Steam scalding has another advantage; it avoids the common bath characteristic of hot-water immersion scalding, thus offering the possibility of reduced bacterial contamination.

In the laboratory equipment now in use, one to four chickens can be steamed. Pilot plant equipment will have to be purchased and tested before many questions, economic as well as technical, can be answered.

Bug that attacks tobacco hornworms

A type of stilt bug is a natural enemy of the destructive tobacco hornworm and may eventually become a useful biological control.

Tobacco hornworms are the best known and one of the most injurious of the tobacco insects. A close relative, the tomato hornworm, is equally injurious to tomatoes. Both species occur throughout most of the United States. They also attack eggplants, peppers, and potatoes.

In tests conducted in Oxford, N.C., ARS entomologist Kent D. Elsey showed that this stilt bug (*Jalysus spinosus*) destroyed at least 49 percent of the tobacco hornworm's eggs in an artificially infested tobacco field.

The insect attacks the eggs by piercing them with its mouthparts and draining the contents.

Eggs were placed on topped and untopped tobacco plants and on the upper or under side of the leaves, but location made no difference in the number of eggs eaten. Topping is the removal of the tobacco plant's flower head, the normal cultural practice.

More research is needed to determine the effect of stilt bugs on a natural infestation of hornworm eggs as well as what practices would encourage these natural enemies of the hornworm.

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Radiation vs. grain insects

The minimum effective dosage of gamma radiation needed to control both the granary weevil and the maize weevil has been determined. Both larvae and adults of these insects feed voraciously, causing extensive damage to a wide variety of stored grains.

Although gamma radiation can be used to control by sterilization any species of stored-product insect, the minimum effective dosage must be applied to keep costs down and to avoid detrimental effects on the products.

Entomologists Gary A. Brown, John H. Brower, and Elvin W. Tilton of the ARS Stored-Product Insects Research Laboratory, Savannah, Ga., treated all stages of these weevils with 5, 10, 20, 30, 50, and 100 krad (measurement of absorbed energy) of gamma radiation from a cobalt-60 source.

Irradiated eggs and larvae of both species were unable to develop to the adult stage at any treatment level. The minimum dosage for sterilizing adults was 10 krad; for pupae, it was 5 krad. Survival time of irradiated adults decreased with increasing dosages.

Manure on millet

Applying 65 tons per acre of dry cattle manure in the surface 8 inches of soil had no harmful effects on root growth of millet in Alabama tests.

However, when this high rate was applied by researchers as a continuous subsurface layer (to simulate plowing it under without mixing), millet roots did not develop in or below the zone of application for nearly 2 months.

Different rates of manure were tested on sandy loam soil at pH 5.5 by ARS soil scientists Robert W. Pearson and Zane F. Lund, Auburn. They say that composition analyses of both soil and soil air indicate that root restriction was caused by inadequate oxygen rather than ammonia toxicity. Nitrate content of percolating water was insignificant with the incorporated manure, but it increased appreciably when the manure was "plowed down."

Top growth of the millet was most rapid at the 65-ton rate of manure. At this rate, millet produced 35 percent more dry forage over the growing season than a 32-ton rate. Also, more forage was produced by incorporated than by layered manure.

The scientists made the study in the new Rhizotron (AGR. RES., October 1969, p. 12) at Auburn University Agricultural Experiment Station.

Protecting cottonseed

Effective nonmercurial seed protectants are available to cottonseed processors as substitutes for alkylmercury compounds, which are no longer registered.

ARS plant pathologist Carleton D. Ranney reports that there are several registered, nonmercurial seed treatment materials which can be used with existing equipment. The change should not cause a major increase in the cost of treating cottonseed to restrict spread of fungus diseases to plants, although some equipment will have to be modified for slurry-type treatment.

The following protectants equalled or exceeded alkylmercury fungicides in controlling seedborne diseases of cotton: Captan, thiram, 2-(thiocyanomethylthio) benzothiazole (Busan 72), and the combination of PCNB and 5-ethoxy-3-trichloromethyl-1,2,4 - thiabendiazole (Terracoat L21). Currently 5-ethoxy-3-trichloromethyl-1, 2, 4-thiabendiazole is registered on an extended basis. These registered nonmercurial fungicides were evaluated throughout the Cotton Belt in 1968, 1969, and 1970 by ARS and State scientists. They were more effective when combined with the systemic fungicide chloroneb.

Two other fungicide combinations, which have not been registered for cottonseed treatment, were also effective—captan with carboxin and tetrachloroisophthalonitrile (Daconil) with *p*-(dimethylamino) benzenediazo sodium sulfonate (Dexon).

When this magazine reports research involving pesticides, it is not implied that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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